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Evaluating the Impact of Addis Ababa Light Rail Transit on Public Transit System, Its Efficiency and Eligibility for Transit Oriented Development (TOD)

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Abstract: Following rapid growth Addis Ababa is experiencing traffic congesting, urban sprawl, farmland conversion and environmental degradation. Addis Ababa LRT (AA- RT) has been envisioned to mitigate these problems by connecting four corners of the city to the Central Business District (CBD) however faced with enormous challenges mainly related to lack of finance to sustain operation. As a remedial measure the city Administration is considering Transit Oriented Development (TOD) as an alternative to overcome the challenges as well as fight the negative effect of the problems by reshaping transport and land use pattern in a sustainable manner. Even though TOD concept has helped many cities around the world detail investigation is should be performed and stockholders should be equipped with adequate knowledge in advance TOD planning and implementation. Since TOD concept is entwined with effective, efficient, fast and frequent transit, evaluating the performance of AA-LRT effectiveness is crucial. The objective of this research is to assess the significance of AA-LRT in improving the public transport system by analyzing the modal share among other public transport; analyzing stations efficiency, and analyze operational efficiency that would eventually give understanding about current situation of AA-LRT. The methodology involves collecting secondary data from relevant office and analyze statistically. The result revealed that modal share of AA-LRT among other public transport is 6%; all stations accommodate less number of passengers than designing and operational efficiency decreasing year after year.

Keywords: Public Transportation, Mode Share, Station Efficiency, Operational Efficiency, Transit Oriented Development

1. Introduction

Public transport such as LRT has a great influence on a city not only improve mobility in a city, but also revitalize the central core directly or indirectly for the benefit of a city. Direct influence would be related to travel efficiency, mainly in the form of reducing commute time and cost; increase public transport ridership; decrease traffic congestion; and decrease private car dependency. Indirect influence would mainly associate with urban development; land value capture mechanism; agglomeration labor market and economy; improving the environment and health situation in the city. Consequently, the impact of a LRT should not be investigated just based on a transit system, but rather based on creating a synergy between urban development effect inclusive of social, economic and environmental [1]. As Addis Ababa is growing rapidly, transformation in the city regarding population growth, agglomeration of the economy, redevelopment effort of the down town core make well suited to sick for rapid transit. Addis Ababa Light Rail Train (AA-LRT) is envisioned to fill these gaps, improve the growing transportation problems, tackle urban sprawling, reduce traffic congestion and offer an alternative public transportation option. However, in its early period of

operation since 2015, it has faced with challenges that would ultimately bring its operation to an end. These challenges have also been emboldened by so many reason, however the main being lack of funding to sustain operation. Since LRT provides affordable transportation for people, it is not expected to sustain financially without subsidy from relevant authority. The Addis Ababa City Administration is considering implementing Transit Oriented Development (TOD) around selected stations along the routes of AA-LRT as remedial measure to overcome the challenges. TOD is a recent urban development concept in favor of moderate to high density residential, office, commercial, public service, and public open amenity development, encourages public transit ridership and non-motorized mode of transport within walking distance around transit stations. The incorporation of public transportation into broader economic and land use can help to reduce sprawl, reduce traffic congestion, expand business opportunity in the city core through TOD. Even though TOD concept has helped many cities around the world, the situation in Addis Ababa is different. Therefore detail investigation of factors for TOD planning and implementation is important step for evaluating applicability of the concept and to equip the stockholder with crucial information they need to acquire and pass important judgment. Evaluating the impact of AA-LRT on city's public transport and its efficiency is among other serious of prerequisites research need to be performed in advance of TOD planning and implementation in order to get the best out of TOD concept since fast, frequent, reliable and efficient transit is a requirement for successful TOD implementation. The research would also help to understand the eligibility AA-LRT for TOD and to provide informant knowledge about TOD among the stockholders. In other perspective majorities of literatures related to TOD are based on cities in developed countries, however the situations in Addis Ababa is different from those cities. Therefore it is crucial to harmonize the TOD concept with the unique characteristics of Addis Ababa.

This particular research focuses on investigating the significance of AA-LRT in improving the Public transportation system in the city; challenges ahead hindering AA-LRT from performing to its best potential and to investigate whether the routes are eligible TOD. The research includes statistical analysis of data from two relevant government bureaus for Analysis. Statistical methods involved in carrying out a study include planning, designing, collecting data, analyzing, drawing meaningful interpretation and reporting of the research findings. Data for this research includes mode share of Addis Ababa public transport, daily passenger number at each of 39 LRT station and LRT operational data from 2015-2021. The result from the analysis show that in all cases (mode share among other public transport mode is only 6%, the number of passengers flow in each of 39 stations are not as it is intended, and internal operational efficiency is getting worst day by day). Therefore it is inevitable to find an alternative solution to improve AA-LRT's performance and tap into the opportunities created by introduction of LRT to create sustainable urban community. TOD is one of the alternatives that would improve performance and nurture sustainable future of urban development since both public transport and TOD capacitates each other.

The research would help to, eligibility of AA-LRT for TOD implementation; maneuver a possible way for the implementation of TOD along the AA-LRT routes capacitate stockholders with informant knowledge in planning and implementation in order to get the best out of TOD concept in Addis Ababa.

Next section is reviewing previous literatures about influence of public transport in a city, financing public transport, and identification of public transport performance indicators; section 3 discusses method and material used for the analysis; section 4 discusses about the result of analysis and section 5 presents conclusions of the research.

2. Literature Review

Pervious literatures demonstrated that public transport can improve mobility in cities as well as affect urban growth, land value capture mechanism and rejuvenate the city as overall economy and sustainability [2-7]". With the introduction of Dallas Area Rapid Transit (DART), Dallas has knowledgeable over $1.3 billion in development and Denver's Lower Down town (LoDo) has been acknowledged as one of the United States' most successful new urban region with the implementation of LRT [5]. However these benefits can only be harnessed when a public transport system is planned with working policies, framework and complementary land-use and transportation integration strategies [2].

Regarding congestion reduction is a one of the main transportation improvement objectives [9] and in order to reduce congestion, rail transit must attract discretionary riders from other mode of transport, which requires fast, comfortable, convenient and affordable service [8]. Reduction in traffic congestion can replicate in the local economy in different ways, such as commute time reduction and man-hours loses reduction. A study by Litman [8] indicated in US cities rail transit services are estimated to provide $19.4 billion in annual congestion cost savings.

Regarding urban sprawl, concentrating development of residential, office, commercial, and public service around transit stations using TOD principle will accommodate more people, who otherwise would have been forced to live in outskirts leading to urban sprawl, by extension increase in dependence on the private automobile, energy consumption, resource depletion and environmental pollution. According to the 1997 World Bank Report, per capital wealth in developed cities decreases with increased car use [10]. Litman stated rail based transports as an integral component of transportation planning, reduce commute trip, encourage smart growth policy, and parking management may be able to reduce total vehicle use by 18–58%[11] which consequently reduces GHG emissions to the atmosphere. In addition health of people would be improved health care expenses consequentially reduced.

In order for a public transport system to deliver services, there need to be healthy and sustainable financial flow. Since the main objective of public transport is to facilitate mobility in a city financing of public transport operations cannot be fully covered by the revenue from ticket fares [12]. Public transport is also designed to provide additional services such as late night services, services for person who needs special attention, rural services with lower fares than would otherwise be impossible for regular people to afford. Therefore supplementary financing such as subsidy from local or federal administration is critical [12]. Implementing TOD around LRT station is one alternative to assist financing and bring private investments into public service directly and indirectly which would improve with increased investment and direct spending on dedicated transportation infrastructure [13].

In metropolitan areas quality of life, economic vibrancy and environment condition mainly depend on the performance of its public transportation like LRT not only by providing opportunities for mobility of people and goods, but also influence the patterns of growth and the level of activity [14]. This approach makes the public transportation system a significant tool to implement TOD. Studies of a light rail system linking Silicon Valley in Santa Clara County, California, found that development around transit nodes was higher than in other areas that is accompanied by incentives such as tax exemptions, public assistance with land assembly, and rezoning permits for higher than normal densities [15].

However for successful TOD fast, reliable and frequent transit is prerequisite. Measurement of public transport performance is important to assess the level of success and identify where performance improvement is needed to fill the gaps [16]. Key Performance Indicators (KPIs) developed by [17] as a part of benchmarking framework which covers the main areas of uptake of public transport, travel efficiency, station efficiently, accessibility and affordability. (VTA, 2007) Set of performance thresholds needed to ensure that LRT routes and stations contribute to produce efficient service and evaluated according to three standards. These are boarding per revenue vehicle hour; boarding per station and boarding per route mile.

3. Material and Methodology

The method used in this research started with introduction of the study area including briefs about Addis Ababa, current public transportation situation in the city and challenges; and introduction about AA-LRT. Since the research is quantitative, it starts with the identification of indicators to evaluate purpose based on the current situation of the city and data availability. Identified performance indicators in case of AA-LRT are mode share AA-LRT in Addis Ababa public transport, efficiency of AA-LRT stations regarding number of passengers boarding at every station, LRT operational efficiency and eligibility for TOD. For the research secondary data have been collected from relevant government offices (Addis Ababa LRT operation office and Addis Ababa Road and Transport Office. These data includes public transport mode share in the city; monthly passenger flow at each of 39 AA-LRT stations; and seven year operation data (2015-2021) of AA-LRT.

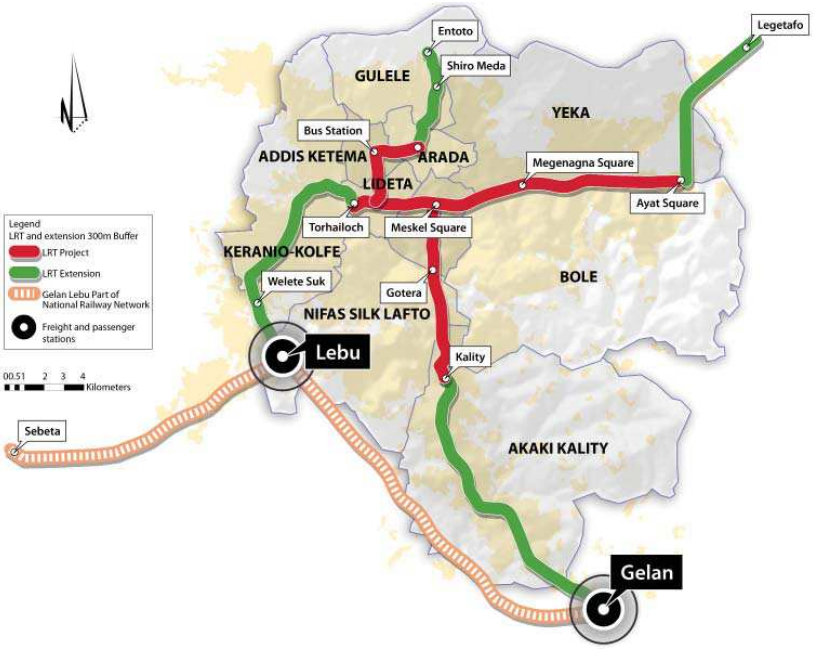

Figure 1. *AA-LRT corridor, connecting 10 sub-cities, future extension. Future connection of LRT with National Railway Network (Source: Ethiopian Railways Corporation (ERC)).*

Nominal Track Gauge:-1435mm
Design capacity:-15,000pphpd (15000passenger per hour per destination) that accounts 60,000PPH.
Working Hours: - 6:00am to 10:00pm
Headway: - 6 minutes but can be reduced to 90 seconds at ultimate capacity

3.1. Study Area

Addis Ababa is going through a multitude of challenges that are intertwined to each other, following recent economic prosperity. These are unregulated population growth, traffic congestion, inefficient infrastructure inefficient use of manpower, farm land conversion following urban sprawl, and increase in living expense. Transportation problem is increasing day by day which has direct and indirect effect to all other challenge. Addis Ababa LRT envisioned to mitigate the transport problem in the city and started operation in September 2015 with financial loan from Chinese Export-import Bank. The project encompasses 31.65km double track line running 17.4Km from East to west and 16.97km from north to south connecting industrial and residential areas to the central business district (CBD). About 2.7km of the stretch is shared by both routes from Stadium station to St. Lideta station. Currently AA-LRT is giving state-of-the-art transport service to the citizens with affordable fares but question of sustainability hanging around it.

The network entirely runs by electricity and studies estimated that the network will reduce carbon dioxide emissions of 1.8tons by 2030 [18] and it has been awarded C40 cities award, prestigious in the transport category in 2016 for its commitment to clean energy. Under normal situation, before COVID-19 restriction, AA-LRT runs approximately every 15 minutes from 6:00am to 10:00pm and carries in average 120,000 passengers a day. However this value is less than 20% of its designed capacity. The Current average operational time taken to upward one-way trip including stoppage time at every station is 54 minutes and down ward trip is 50 minutes. And average of operation speed is 20 Km/hour.

3.1.1. Challenges of AA-LRT

Even thought AA-LRT has sparked hope in perfecting public transportation system in Addis Ababa, it has faced with stumbling blocks that would challenge its sustainability at its early age of operation mainly due to lack of adequate financial support and appropriate skill to run operation. Some of these challenges are:

According to AA-LRT service office LRT experiences more than 5,000 delays a year, mainly due to power blackout and driver's immaturity.

Although the basic unit of AA-LRT is two vehicles (coupled), but often runs as one (single) vehicle due to the lack of spare parts. In addition, there is a cancellation schedule in accordance with delays. It became a serious cause for deficit operation.

According to design the headway time for deployment of the train is 6 minutes, but passengers have to wait more than 15 minutes because shortage of trains.

Because Electronic (digital) Ticketing System is not implemented yet, passengers have to cross busy traffic to buy a ticket for their trip, which potentially decreases preferably of LRT to other modes of transport such as buses and minibus.

Absence of Passenger Information System (PIS) at stations decreases preferably of AA-LRT as well.

3.1.2. Public Transport Situation in Addis Ababa

Major modes of public transport in Addis Ababa are buses, mid-buses, minibuses, salon taxis and tricycles in local name called bajaj. Buses with capacity more than 70 passengers (Anbessa Bus, Sheger bus and PSETSE bus) Mid-buses with the capacity 30 passenger (Higer bus and Kitkit) and minibus with capacity of 12 passengers (code 1 and code 3) are the main public components in Addis Ababa. Higher capacity buses and AA-LRT are run as public property and minibuses, Mid-buses and tricycle (bajaj) run by private individual under different transport associations. Even though there are numbers of public transport services in Addis Ababa, the service can be described as inefficient; poor institutional framework and ineffective transport management system. The service provision is based on computational manner rather than subsidiary to each other. In other hand the public transport is in most cases, associated with poverty stricken people and equated to lower living standards where as car ownership is often related to better living standards. It is in contrary to famous mayor of Bogota, Colombia (Enrique Penalosa) who championed Bogota BRT quote "a developed country is not a place where the poor people own a car it is where the rich people use public transport".

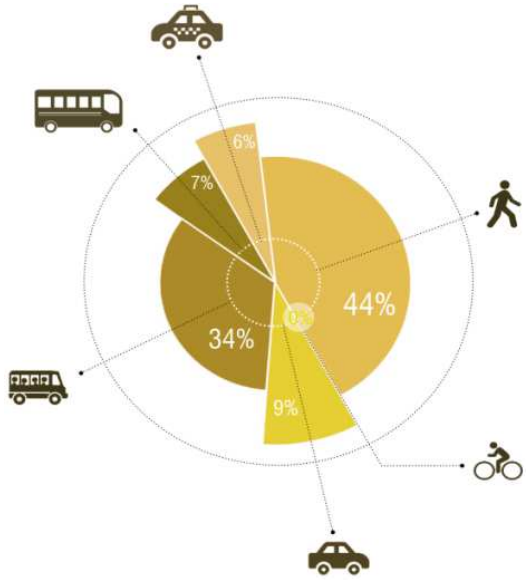

Figure 2. *Transportation mode share of Addis Ababa city (source: ARUP, 2015).*

Walking dominates mobility share by 44%, without a friendly pedestrian environment. Even though the number of private cars out numbers other car types, its mobility share is only 9% in 2014 and grows to 15% in 2019 according to [19] which leads to inefficient use of infrastructure, fuel, and resource. Cycling, which is supposed to be encouraged in urban transport, effective for distances less than 5Km according to; [20, 21] is almost accounts 0%, mobility share of all mass transport.

Even though it is very expensive to own private vehicle in the country compared to others countries, private car is becoming basic necessity in the city because people are forced to have a car because of inefficient public transport. This culture has persevered and leading to traffic congestion in the city. And because of traffic congestion in the city, average speed in the city is 10Km/hour. It is like one problem leads to other.

3.2. Identification of Indicators and Analysis

Since transport orientation in a city is highly complicated due to the modes involved, the multitude of purpose, destination, origins and variety of traffic [22] it is necessary to identify Key Performance Indicators (KPI) that can be used to measure performance as well as identify gap to improve. KPIs need to be specific, measurable, achievable, relevant, and timely to meet the need of purpose. Because the purpose of this research is to evaluate the impact of AA-LRT on Public Transit System, its efficiency and eligibility for TOD; the KPIs focused for this research are the mode share of AA-LRT among other public transport; efficiency of stations regarding the number of passengers at each of 39 stations; and operational efficiency of AA-LRT regarding daily passenger volume and yearly trip cancelation. Because fast, frequent, reliable and efficient transit is prerequisite for successful TOD the result of the above analysis would give informant understanding for the eligibility of AA-LRT for consideration of TOD planning and implementation.

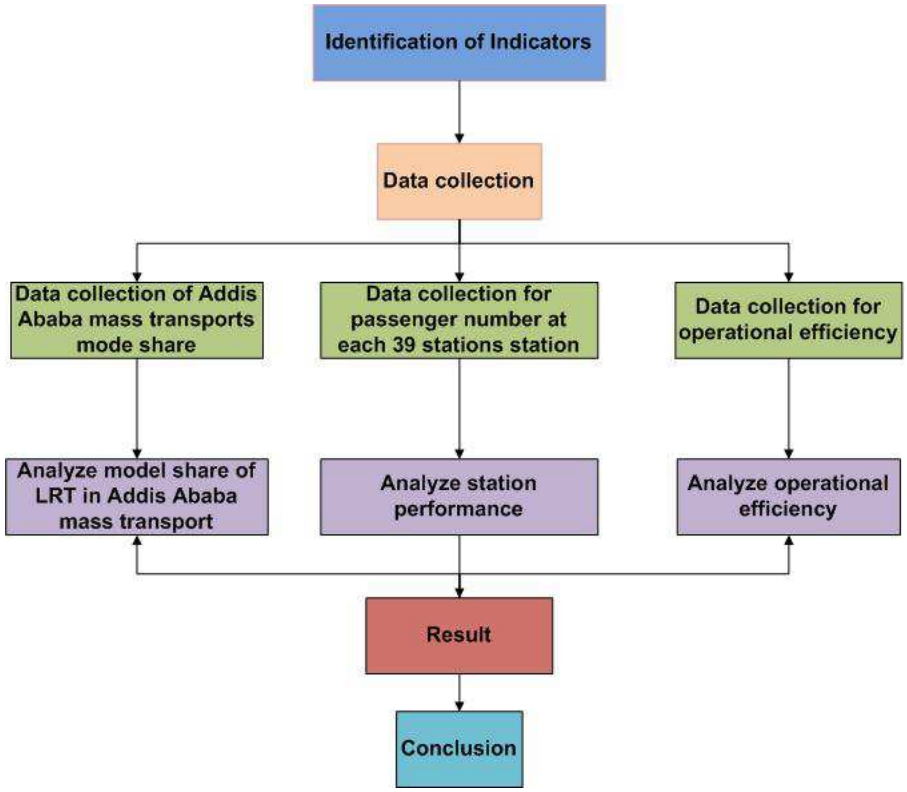
Identification of Indicators
Data collection
Data collection of Addis Ababa mass transports mode share
Data collection for passenger number at each 39 stations station
Data collection for operational efficiency
Analyze model share of LRT in Addis Ababa mass transport
Analyze station performance
Analyze operational efficiency
Result
Conclusion

Figure 3. *Research methodology flow diagram (Source: Authors).*

3.3. Data Collection

Secondary data needed for the assessment has been collected from relevant authorities. For the analysis of mode share, data has been received from Addis Ababa Road and Transport Bureau. This data includes mode share of all public transport modes in Addis Ababa from 2015-2020 ever since LRT came to operation. For the analysis of stations efficiency and general operational efficiency of AA-LRT, data has been received from Addis Ababa LRT operation office.

3.4. Data Analysis

In all three cases (analyzing mode share, station efficiency, and operational efficiency) statistical methods has been used in carrying out the analysis. Statistical method used to carry out data analysis and draw meaning full interpretation and report of research finding.

3.4.1. Mode Share of AA-LRT Among Other Public Transport in Addis Ababa

The mode share of AA- LRT among other transportation mode in the city has been assessed by analyzing data from Addis Ababa Road and Transport Office. The data includes daily passenger number of all public transports in the city, number of deployment routes for each public transport, average passenger volume and number of operational buses or train. The analysis to investigate the mode share of AA-LRT among other public transport mode is made changing the number of daily passenger volume into percentile and visualize on pie chart using Microsoft excel. See the result in figure 4.

3.4.2. Performance of Each of 39 AA-LRT Stations

The passenger number in every station is crucial indicator to assess performance of rail based public transport. This measures the number of daily passenger boarding at each of LRT station and gauge how well a station is being utilized. It would help to investigate which station gate large number of passenger and what is the reason behind. (VTA, 2007) Stated that underutilized station impacts LRT operating performance as well as ticket fare recovery and cost efficiency. For this research Monthly passenger flow data of each of 39 stations received from AA-LRT operation office and has been converted to daily passenger boarding at each station. Using Microsoft Excel converted daily passenger flow has been put on horizontal bar graph. The result displayed on figure 5 shows all stations failed to achieve intended goal of 20,000 passengers per day but there is also big variation in number of passenger boarding in each station. Future studies on each particular station would benefit a lot to understand the reason behind these big variations. It would also help to understand what kind of improvement plan needed to be taken and the criteria to choose location for future stations.

3.4.3. General Operation Performance

It is such common to evaluation and monitor operational of public transport to identify the gap that need to be improved. Seven years (from 2015 to 2021) used to investigate the operational efficiency of AA-LRT. The data includes yearly passenger ridership, yearly train delay, and yearly trip cancelation. Since the operation started in September 2015 and 2021 are not finished yet, the data from 2015 and 2021 is not has not been incorporated in the yearly analysis. Using Microsoft excel prepared data converted to simple bar graph to visualize. The result is displayed on figure 6.

4. Results and Discussions

The result s of the analysis indicated that in all aspect of performance indicator (assessing mode share, analysis of efficiency of stations and general operational performance) AA-LRT is not performing at as it is expected. In order to play a greater role in improving public transport system, much reform is needed regarding integration of all public transport in subsidiary manner with AA-LRT. Transit Oriented Development (TOD) concept that focuses on integration of transport and land use can be started by creating harmony between all public transport modes. Cycling which is the main component of TOD has not yet introduced as non-motorized transport modes. Introduction of cycling is expected increase the influence LRT has on public transport in Addis Ababa. For more clarity the result section will be divided into three: first, analysis results illustrating the mode share of AA-LRT on Addis Ababa public transport, second, the result of station efficiency, and third, result of operation performance.

4.1. Mode Share of AA-LRT in Addis Ababa Public Transport

The results of modal share of AA-LRT on public transport and its impact on improving public transit situation in Addis Ababa indicated that the modal share is only 6% and its impact in modernizing public transportation is also insignificant. Comparing the analysis result with designed capacity of AA-LRT, LRT is working under 20%. The level of integration with other public transport system in the city is very poor. There are a lot of internal and external reasons to mention for its poor performance. The main being AA-LRT design has not considered the main input such as station location and arrangement; route alignments; population (inconvenience of ticketing, absence of the Passenger Information System (PIS), frequent power blackout, inconvenience of elevated stations etc...) shortage of spare parts hindering AA-LRT from deploying more trains.

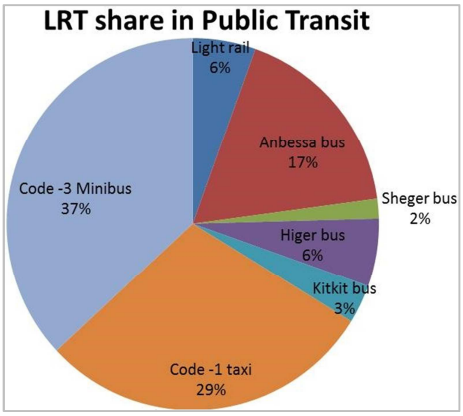

Figure 4. *Public transit share of AA-LRT in Addis Ababa (Addis Ababa Transport Office, 2019).*

LRT share in Addis Ababa public transport is not significant as of yet only 6%, and there is no growing trend.

Shortage of trains, inconvenience of ticket shops, absence of PIS, and lack of public amenities at the station played a part in the lower mode share.

Big share of public transport goes to minibuses (code1 & code3) with a capacity of 12 people but make up to 66%.

There is also no framework that integration of all public transport systems (LRT, BRT, city buses, minibuses, and taxis) together with non-motorized transport that would have increased the number of LRT ridership. Basic unit of LRT is two vehicles, but often runs as one vehicle due to the lack of spare parts. In addition, there is a cancellation schedule in accordance with delays. It became a serious cause for deficit operation.

4.2. Analysis Result on Station Efficiency

Since LRT stations are the primary interface between customers and service, stations play crucial role for the successful and efficient operation of LRT. In order to discharge this role stations need to be attractive, well designed and locate at appropriate site to provide convenience, safe and easy access. Based on availability of data, in this research the efficiency of the stations has been analyzed by the number of commuters taking LRT at each of 39AA-LRT stations to travel to their destination. For the suck of clarity in this research the stations are divided into three categories based on routes. These are the stations on East-

west route, North-South route and common (shared) route.

4.2.1. Stations on East-West Routes (Ayat to Torhailoch) Red Color in Figure 5

The first 17 station in the figure 5 are included in this group. It starts from Ayat at the east and ends up at Torhailoch at West end. As it can be noticed in figure 5, daily passenger volume at stations shows that the maximum passenger number is recorded at starting stations such as Ayat and Torhailoch. On the same route such as Megenagna station in the middle also has somehow bigger passenger volume. There are different factors played for such significant fluctuation in the figure such as:

People choose LRT for long distances because of convenience, comfort, and cost. The starting stations for East-West routes are situated nearby residential areas as well as subsidiary transport stops (buses, minibuses) situated nearby those stations.

LRT is much faster than other modes of transport for long distance 20km/ha as compared to 10km/hour in case of other modes especially during rush hour due to traffic congestion.

As per the analysis, the stations hosting the lower number of daily passengers are Salite mihiret station, Gurd shoal 2 station. The reason behind this is: Inconvenience of the station for passengers to access the station crossing busy traffic and inconvenience of ticket shop. There are also no residential and subsidiary transport stops nearby those station.

Generally, the factors mentioned above (convenience of station for passenger availability, of densely populated areas around the station, availability of transit stops nearby the stations demonstrates the fact that Transit Oriented Development would help to increase ridership.

4.2.2. Stations on North-South Route (Kality to Menelik 2nd Square)

The passenger numbers at North-south route stations are still much lower than the anticipated but diversely distributed than stations on East-West. Maximum recorded number of passenger is at Autobus Terra station. In case of North-South route the starting stations (Kality and Menelik 2nd square) have higher passenger volume as it is on the East-West route but the magnitude about half of East-West route starting stations. Availability of the regional bus station nearby Autobus Terra has contributed to the station's higher passenger number.

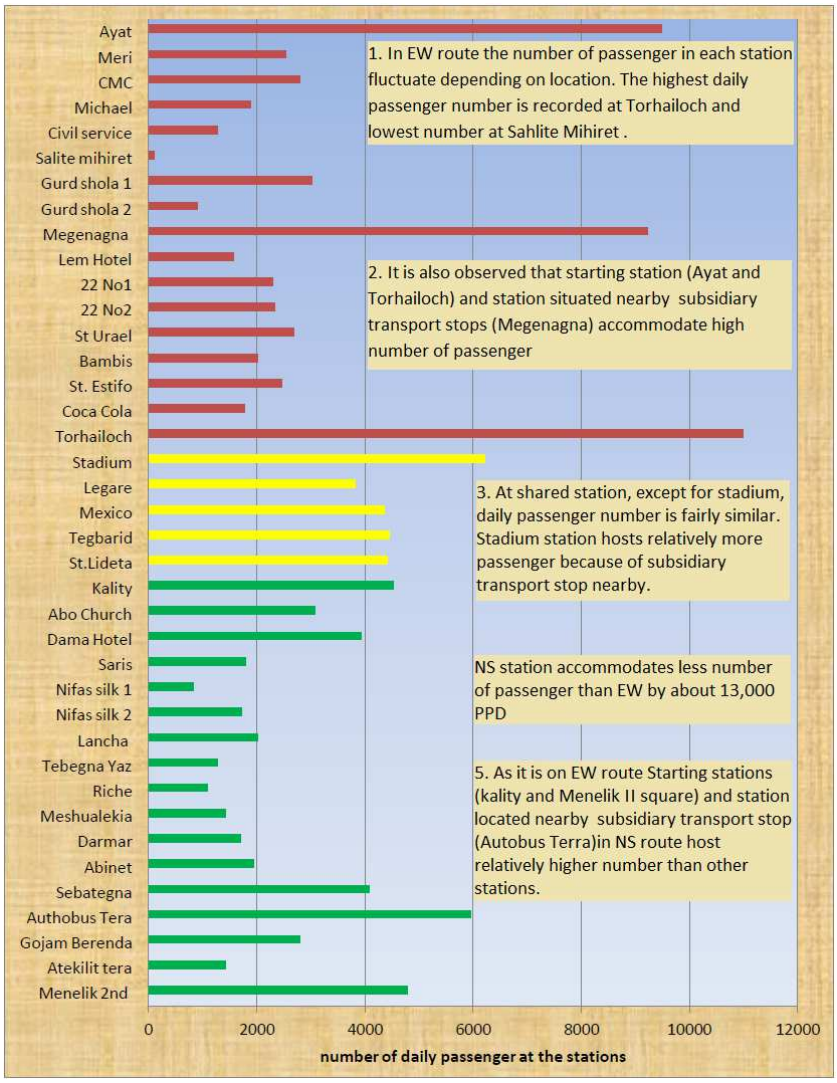

Figure 5. *Passenger number at each of 39 stations in AA-LRT corridor (data source: Addis Ababa LRT Operation Office).*

4.2.3. Shared Stations (Five Stations in the Middle Stadium to St. Lideta) Yellow Color in Figure 5

The stations located at shared route by both (East-West and North-South) relatively uniform passenger number. However, considering the location at Central Business District (CBD), the passenger is expected to be higher but it is not as per the analysis result the main reason behind is the stations at this section are elevated and lifts and elevators are not operational. Generally the stations are not simply accessible.

4.3. Analysis Results of Operational Performance AA-LRT

When it comes to operational efficiency, the performance of AA-LRT is plummeting day by day. As per the analysis result of yearly passenger volume and yearly trip cancelation the operation is in worst condition. Passenger ridership which is supposed to increase with operation year goes by attracting more rider is trending negative. Trip cancelation is increasing with alarming rate because of different reason which is bad sign in operation.

4.3.1. Yearly Passenger Flow

Yearly passenger flow is important parameter to evaluate the operational performance of a public transit system. Under good operational performance, the passenger number increases year by year, attracting riders from other modes of transport. But in the case of AA-LRT as it can be seen in the figure below passenger flow is not changing much except for 2020 when the COVID-19 has forced to restrict limited number of passenger to board in which case decreased number of passenger. However, after the restriction, the number does not show any bouncing back to expectation. Regression result in the figure 6 shows negative trend.

4.3.2. Yearly Trip Cancelation

Trip cancelation is also increasing with alarming rate and it shows that the operation is not in good condition. Resent evidence shows operation pause for half of daily operation period. Regression result of yearly train trip cancelation shows steep positive slope which also an indication of bad operation condition.

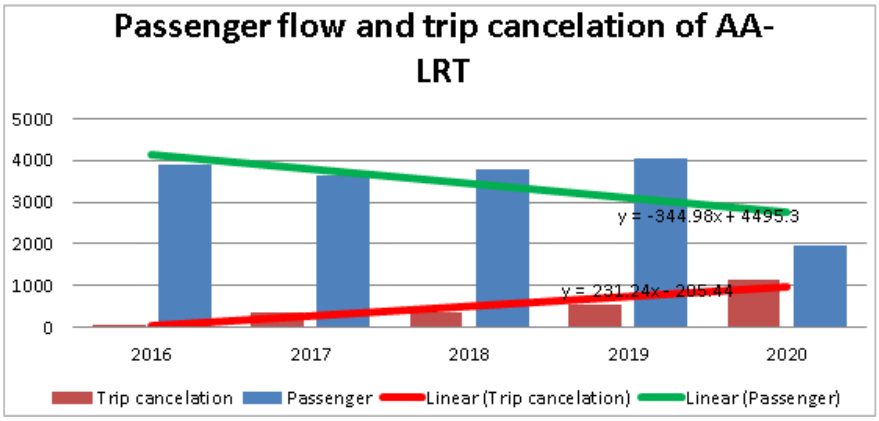

Figure 6. *Graph showing operational efficiency of AA-LRT using the trend of yearly passenger flow, yearly train travel in Km, and yearly trip cancelation (data source: Addis Ababa LRT Operation Office).*

5. Conclusion

This research focused on assessing the influence of AA-LRT in improving public transportation system in the city, station efficiency and its operational performance to grasp the understanding if it is worthy to implement TOD along the transit corridor. Because to having high capacity, efficient, fast, reliable and frequent public transport system is prerequisite for TOD. The research revealed the fact that Addis Ababa LRT had no significant influence on the public transport system in Addis Ababa; its mode share is only 6% and diminishing day by day with alarming rate.

When it comes to daily number of passenger volume at each of 39 stations, the number is far below anticipated. Since stations are a gateway face of service, they would have a big impact on the success of LRT as a system by providing access to the transit and update information to costumers. To play these crucial role stations should be equipped with facility provider; appropriate facility sizing and components such as amenities, facilities that should support access for customers of all ages, bicycle, buses, and auto/taxi pick up and drop off, park and ride and layover facilities. Almost all AA-LRT stations failed to proved those essential facilities and components. There is big variation in number of passengers boarding at each station. In addition to that the stations are located at inconvenient location where ticket shops far away from the station.

Operational efficiency indicated that it is worsening day after day; passenger number is dropping, trip cancelation rate is increasing due to several factors.

Generally because fast, reliable, efficient and frequent transit is prerequisite for successful TOD the current situation AA-LRT as rapid transit is not qualified for TOD unless appropriate measures are taken to make the transit fast, reliable, efficient and reliable. In addition it would also advisable to have further research regarding the possibility that TOD can help the transit to improve its efficiency.

6. Recommendation

In order to sustain AA-LRT operation, fundamental reforms need to be undertaken which includes;

All other public transport components (buses, minibuses, taxis) need to be integrated to AA-LRT in subsidiary manner.

Funding need to be injected to fulfill spare part needs to lift AA-LRT operation to full capacity.

The stations should be equipped with necessary amenities, passenger information display system, security systems and universal accessible.

Provide capacity building training for management and operation staffs.

Currently ticket centers are inconvenient for passenger to by ticket, which is pushing away plenty of costumers. Ticketing system need to be digitalized that commuters can buy ticket using their cell phone or card.

AA-LRT should be equipped with intelligent transport system (ITS). Generally in order to make AA-LRT fit for TOD; there must be good understanding about public transportation and TOD among the stockholders about the role of large-scale infrastructure investments like LRT and TOD, particularly among public officials and city leaders.

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